Collaborative Knowledge in Asynchronous Collaboration (CASC)

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Project Goal & Objectives

- **Overall Goal:** **understand the unique cognitive mechanisms that should h employed to**

  optimize collaborative decision-making activity in a geographically distrib and

- **Objectives:** **(1) to understand the cognitive process of building knowledge time-delayed situation in an asynchronous, distributed collaboration environment**

  (2) to develop an empirically-based theory of collaboration, including knowledge building components, during asynchronous, distributed collaboration

  (3) to understand how agents can support humans in achieving collaborative knowledge during asynchronous, distributed collaborative problem solving

- **FY 03 Objectives:**

  (1) Conduct experiments in collaborative problem solving in both face-to-face and asynchronous, distributed environments to understand the unique cognitive processes within asynchronous, distributed collaboration

  (2) Update preliminary conceptual model of collaboration based on experimental results

Definition of Key Terms

- **Collaboration = the process of shared creation: two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own (Schrage, 1990)**
  - **The cognitive aspects of joint problem solving for the purpose of attaining knowledge sufficient to complete the common task.**
- **Asynchronous Distributed Collaboration = a cohesive group of individuals working at different times and at different locations to solve a common task (Baecker, 1993)**
- **Knowledge Building = process through which we increase both our indiv common understanding (Wells, 1999) ; theory of learning, which emphasize collaborative construction of knowledge by a group of learners (McLean, 19**
- **Collaborative Knowledge = group negotiation of different perspectives resulting in a broader and deeper understanding (Stahl, 2000; Warner & Vanderwalker, 2002)**

Definition of Key Terms

- **Shared Understanding = agreement by the group achieved through clarification of differences**

  in interpretation and terminology (Stahl, 2000)

- **Mental Model = a knowledge structure that represents information (Norman, 1983)**

- **Shared Mental Models = organized knowledge members have in commo regarding the**

  task (Cannon-Bowers, et al., 1993)

- **Agent = software that carries out some set of operations on behalf of a use**

  or another program with some degree of independence or autonomy, and in so doing,

  employ some knowledge or representation of the user's goals or desires (Franklin &

  Graesser, 1996)

Expected Final Products

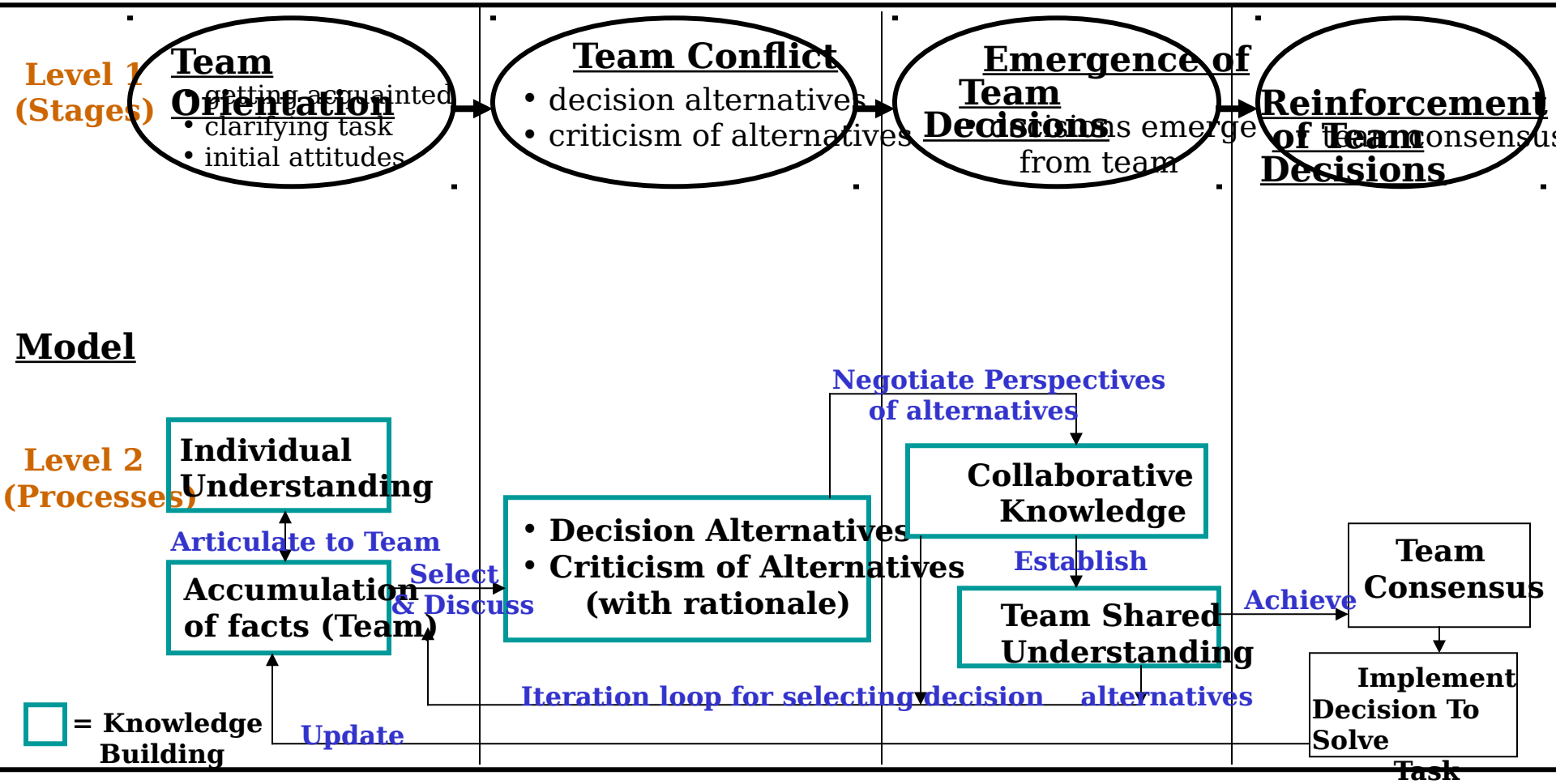
- **Empirical Data / Journal Articles**
  - **Describing the cognitive processes of building knowledge with distribut team members engaged in asynchronous, quick response collaboration**
  - **The data, derived from Phase I, and II experiments, will be documented in journal articles**

- **Empirically-based Theory For Asynchronous, Distributed Collaboration including Knowledge Components**
  - **Theory will be documented in a journal article**

- **Empirical Data On Agent Support For Achieving Collaborative Knowledge In Asynchronous, Distributed Collaboration**
  - **The agent support experiments (Phase III) will be documented in a jou**

Conceptual or Computational Models Developed/Planned

Preliminary Conceptual Model of Collaboration



Research Questions

• **What is the knowledge building process humans use in asynchronous, distributed**

collaborative problem solving?

• **Understand the effect of the following variables on the knowledge building process**

during asynchronous, distributed collaboration?

*** Collaboration Modes (face-to-face versus asynchronous, distributed)**

*** Knowledge Distribution (homogeneous versus heterogeneous)**

*** Problem Solving Domains (static knowledge versus dynami knowledge)**

• **What forms of agent support facilitate knowledge building in asynchronous,**

Experiments (Planned / Completed)

Overview of Phase I, II, and III Experiments

- **Phase I Objective = collect empirical data on the knowledge building pr collaborative problem solving domain (group survival scenario) during asy distributed collaboration**
  - **Examine the effects of collaboration mode(face-to-face vs asynchro and knowledge distribution (homogeneous vs heterogeneous)**

- **Phase II Objective = building on phase I examine the effects of differen domains (static vs dynamic knowledge) on the knowledge building proces**

- **Phase III Objective = within the context of the revised theory for know in asynchronous, distributed collaboration (based on Phase I and II result empirically examine the beneficial forms of agent support?**

Team Problem Solving Task

Survival Scenario

Your group has secured the use of the company jet to fly over the Rocky Mountains for a business meeting on the other side. While flying over an uninhabited stretch of mountains a problem with an engine and rough winds force the pilot to fly low, causing loss of radio contact. Some time later a severe gust of wind causes the plane to veer into the top of a tree. The contact with the tree rips part of the underside of the wing causing the pilot to lose control and the plane to veer toward the side of the mountain. After your small light aircraft crashes your group, wearing business clothing, is stranded on a forested mountain in appalling winter weather (snow covered, sub-freezing conditions) at least 200 miles from civilization (you are not sure of your whereabouts and radio contact was lost one hour before you crashed, so the search operation has no precise idea of your location). The plane is about to burst into flames and you have a few moments to gather some items. Aside from the clothes you are wearing (which do not include coats), you have no other items. It is possible that you may be within mobile phone signal range but unlikely.

Your aim is to survive as a group until rescued. From the following list choose just ten items that you would take from the plane (all of which will otherwise be destroyed by fire).

First take 10 minutes by yourself and come up with your own list of ten items.

Then as a group discuss and agree on a 10 item list on behalf of the group (unlimited time).

SURVIVAL SCENARIO
Item List

Choose ten from the following list of items - splitting or only taking part of items is not permitted:

- Pack of 6 boxes x 50 matches.
- Roll of polythene sheeting 3yrd x 2yrd
- 1 case of beer (24 12 oz bottles in total)
- 1 bottle of brandy
- 1 12 pack of bottled spring water (twelve liters in total).
- Small toolbox containing hammer, screwdriver set, adjustable wrench, hacksaw and large penknife.
- Box of distress signal flares.
- Small basic first-aid kit containing plasters, bandages, antiseptic ointment, small pair of scissors and painkiller tablets.
- Mobile phone with battery half-charged.
- Clockwork transistor radio (receive only).
- Gallon container full of fresh water.
- Box of 36 – 1.8 oz chocolate bars.
- Shovel.
- Short hand-held axe.
- Handgun with magazine of 20 rounds.
- 20yrd of 450lb nylon rope.
- Box of 24 – 1oz bags of peanuts.
- Bag of 10 mixed daily newspapers.
- Box of tissues.
- Bag of 20 fresh apples.
- Electronic calculator.
- Laptop computer with infrared port, modem, unknown software and data, and unknown battery life.
- Inflatable 4-person life raft (yellow colored, with paddles).
- Compass.
- Large full Aerosol can of insect killer spray.
- Small half-full aerosol can of air freshener spray.
- Notebook and pencil.
- Box of size 8 women's promotional pink 'Barbie' branded fleece-lined track suits (2 suits total).
- Gift hamper containing half-bottle champagne, large tin of luxury biscuits, box of 6 - 3 oz mince pies, 1 oz tin of caviar without a ring-pull, a 12 oz tin of ham without a ring-pull, and a 18 oz Christmas pudding.
- Traveling games compendium containing chess, backgammon and draughts.
- Sewing kit.
- Whistle.
- Flashlight with a set of spare batteries.
- Box of 50 night-light 6hr candles.
- Bag of 6 large blankets.
- 2 rolls of duct tape.
- 1 carton of cigarettes.
- 8x32 waterproof binoculars.

Experiments

Phase I Experiments

***Independent variables*:**

- *Collaboration Mode* (face-to-face vs asynchronous, distributed)

*** Face-to-Face = team interacts synchronously with each other through speech**

*** Asynchronous, Distributed = team interacts with each other at different times and from different locations through a text based web forum**

- *Knowledge Distribution* (homogeneous vs heterogeneous)

*** Homogeneous = the members of the team have all survival knowledge in common**

*** Heterogeneous = the members of the team all have both some survival knowledge in common and some uniquely held survival knowledge**

Phase II Experiments

***Independent variables*:**

- Collaboration Mode & Knowledge Distribution

- Domain (static knowledge vs dynamic knowledge)

EXPERIMENTAL DESIGN FOR PHASE I AND II EXPERIMENTS

(2x2x2 randomized factorial)

Knowledge Distribution →	Static		Dynamic	
Collaboration Mode ↓	Homogeneous	Heterogeneous	Homogeneous	Heterogeneous
Asynchronous, Distributed (text)	Gp 1 * * Gp 8	Gp 17 * * Gp 24	Gp 33 * * Gp 40	Gp 49 * * Gp 56
Face-to-Face (speech)	Gp 9 * * Gp 16	Gp 25 * * Gp 32	Gp 41 * * Gp 48	Gp 57 * * Gp 64

Phase I

- 32 groups total
- 3 subjects / gr
- 96 subjects tot

Phase II

- 32 groups total
- 3 subjects / group
- 96 subjects total

***DEPENDENT VARIABLES*:**

- Forum text and face-to-face audio / video recordings including time stamp per response (I.e. text and speech)

- Thinking Aloud Protocol (concurrent verbalizations) for asynchronous, distributed teams

- Total time to successfully complete the problem-solving task (time from the beginning of the task until task completion)

- Collaboration Maps (pre / post session – subjects construct a map of their view of the stages & processes of team collaboration)

- Subjective Questionnaire – measuring expertise, trust between team members, and general collaboration opinions among members

HYPOTHESES

- **Phase I Experiment**

Ho: no significant difference between face-to-face and asynchronous, ributed collaboration modes on the knowledge ding process in a collaborative problem solving domain

Ho: no significant difference between homogeneous and erogeneous knowledge distribution on the wledge building process in a collaborative problem solving omain

Ho: no significant interaction between collaboration modes and wledge distribution on the knowledge building process

Ho: no significant difference in time or frequency within each wledge state across collaboration mode and knowledge ribution conditions

Ho: no convergence of individual mental models with regard to aboration stages and knowledge processes

- **Phase II Experiment**

Ho: no significant difference between static and dynamic knowledge on the knowledge building process in a collaborative problem solving domain

NAVAIR

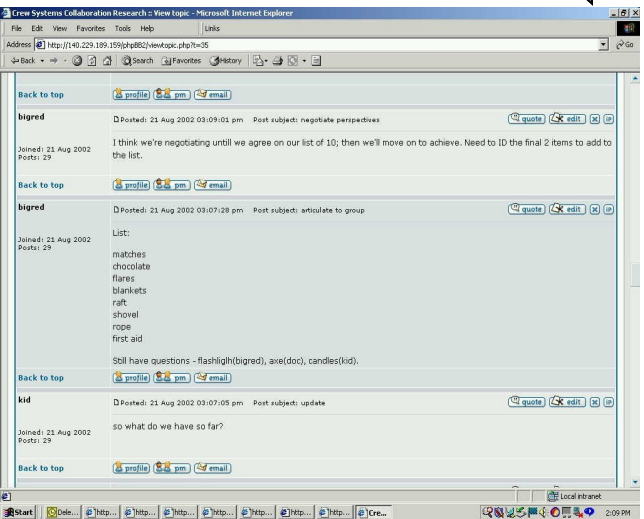
COGNITIVE AND AUTOMATION RESEARCH LAB (CARL)

Asynchronous, Distributed Collaboration Stations

Experimenter's Station

Face-to-Face Collaboration Area

Web Based Text Forum


Crew Systems Collaboration Research :: View topic - Microsoft Internet Explorer
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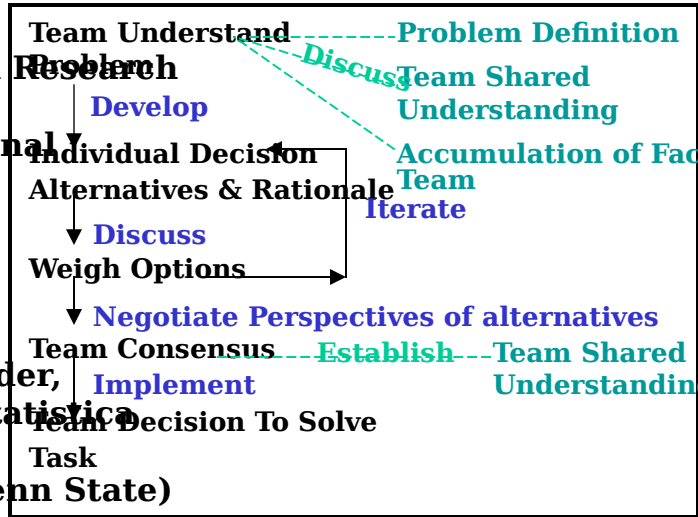
bigred
Posted: 21 Aug 2002 03:09:01 pm Post subject: negotiate perspectives
I think we're negotiating untill we agree on our list of 10; then we'll move on to achieve. Need to ID the final 2 items to add to the list.
Joined: 21 Aug 2002
Posts: 29
bigred
Posted: 21 Aug 2002 03:07:28 pm Post subject: articulate to group
List:
matches
chocolate
flares
blankets
raft
shovel
rope
first aid
Still have questions - flashligih(bigred), axe(doc), candles(kid).
kid
Posted: 21 Aug 2002 03:07:05 pm Post subject: update
so what do we have so far?

Experience & Capabilities

- **Over 25 Years Experience in Decision Making / Automation Research**
- **Member National & International Research Panels**
- ***Recent efforts*: CASC, Agent Learning, ADSS, ANGEL, SCC**
- ***Tools*: local web server, Pathfinder, Agent development toolsets, Statistica**
- **Joint University efforts (e.g. Penn State)**

Collaboration Maps (exan



Web Site Knowledge for Knowledge Distribution Conditions

(Homogeneous / Heterogeneous)

First Aid

- Sprains and Fractures
- Bleeding
- Hypothermia
- Snow blindness
- Shock
- Dehydration
- Psychological well-being

Food

Table 1 contains nutritional information a
various types of food and alcoholic bevera

- Beverages
  - Water
  - Alcohol
- Nature's Food - getting food from the enviroment
  - Hunting animals
  - Trapping animals

Rescue and Escape *

Rescue

Visual Signals Examples

- Fire
- Smoke
- Flare gun and flares
- Mirrors or Shiny Objects
- Flashlight

Audio Signals Examples

-Whistles - Mobile Phone
- Gunshots - Banging objects

Escape

-Compass
- Maps
- Sled
- Snowshoes
- Visibility

* Common knowledge in heterogeneous

Shelter

Shelter types (examples):

- Ice fishing
- Fruits, plants and n
- Fallen Tree Shelter
- Fallen Tree Shelter
- Tree Pit Shelter

Warmth

- Fire Basics
- Starting a Fire
- Helpful Fire Starting Tips
- Insulating the Shelter

Team Collaboration Map Template
(Pre & Post Session)

Collaboration Stages

- Implement Team Decision To Solve Task
- Weigh Options
- Team Orientation
- Team Consensus
- Team Leader
- Team Decisions
- Team Understand Problem
- Individual Decision Alternatives & Rationale
- Additional stages (you label)

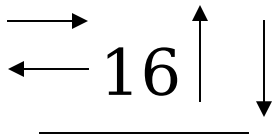
Types of Knowledge

- Domain Experience
- Team Shared Understanding
- Life Experience
- Critique of alternatives & rationale
- Problem Definition
- Collaborative Knowledge (I.e. deeper team understanding of decisions)
- Accumulation of Facts by Team
- Individual Understanding
- Additional types (you

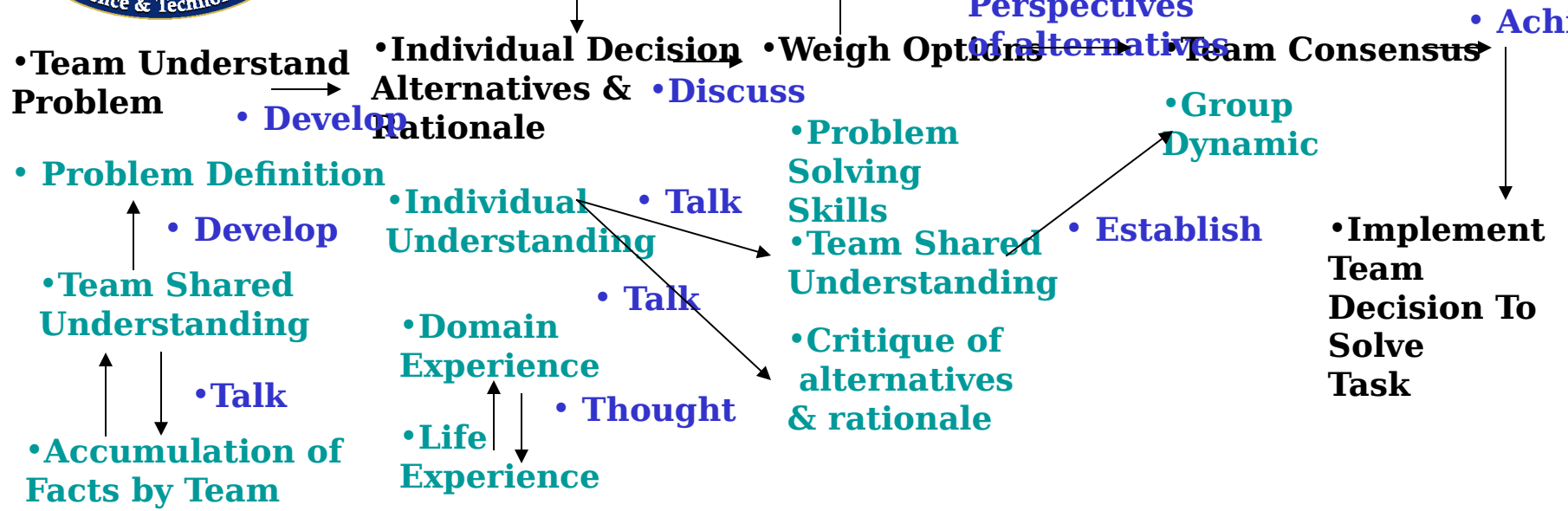
Process to Achie

- Achieve
- addition
- Update (you label
- Read
- Iterate
- Discuss
- Select
- Develop
- Establis
- Talk
- Negotiate Perspectives of alternatives

Connecting Arro



Team Collaboration Map Example (post session)



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Connecting Arro

TYPES OF DATA ANALYSES

Phase I, II and III Experiments

- **Communication Analyses with Pathfinder tool – identification and representation of knowledge state types, and knowledge building transformation processes compared across collaboration mode and knowledge distribution. Compare results to preliminary conceptual model.**

- **Verbal protocol analyses with Pathfinder tool – additional information on knowledge states and transformation processes with asynchronous, distributed teams. Compare to conceptual model.**

- **Parametric statistics for analyzing time, and frequency within each knowledge state across collaboration mode and knowledge distribution conditions in addition to total time to complete task and questionnaire data.**

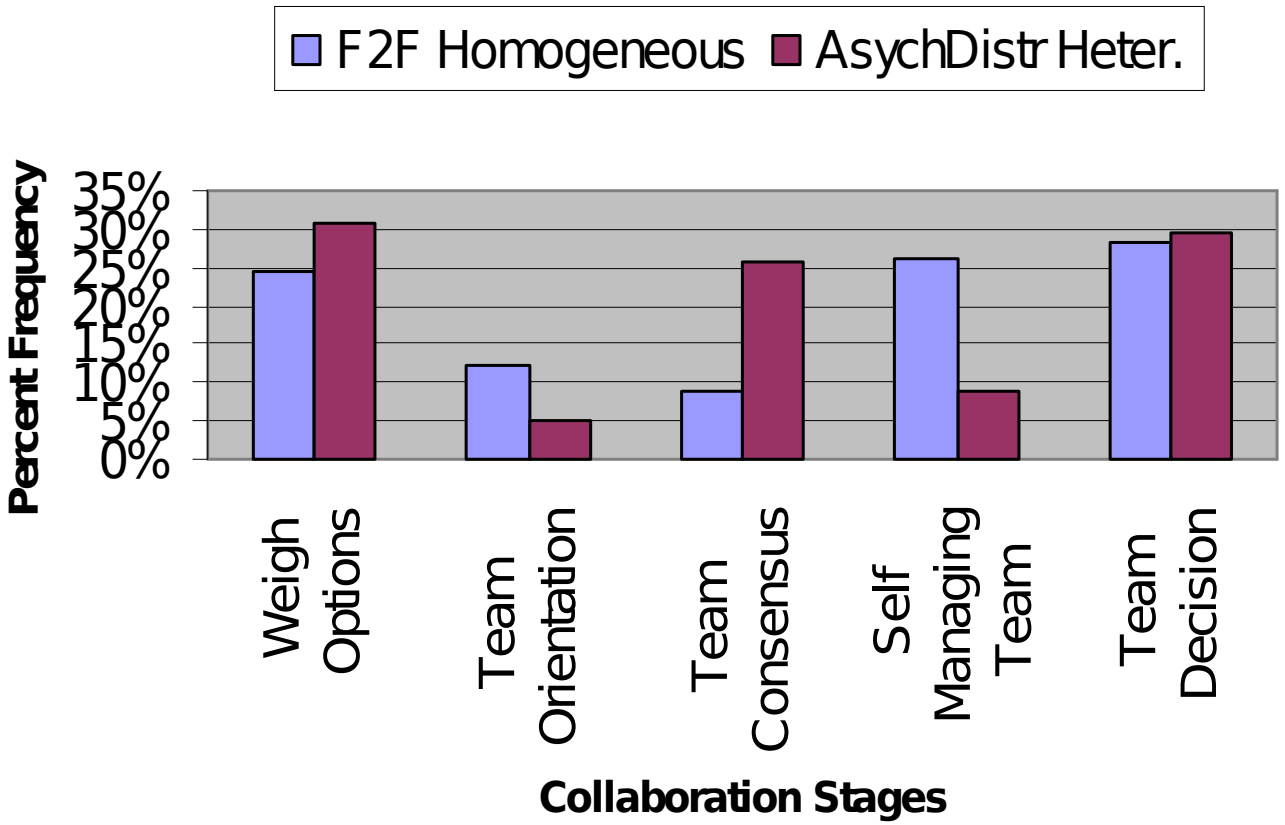
- **Collaboration Maps – determine the degree of convergence between individual mental model ‘s regarding collaboration stages and processes. In addition, compare how an individual thinks a group makes a decision in a collaborative setting and how the group actually performs.**

Pilot Study Results

Communication Analysis Example

Face-To-Face Homogeneous vs Asynchronous Distributed Heterogeneous

Percent Frequency By Collaboration Stages

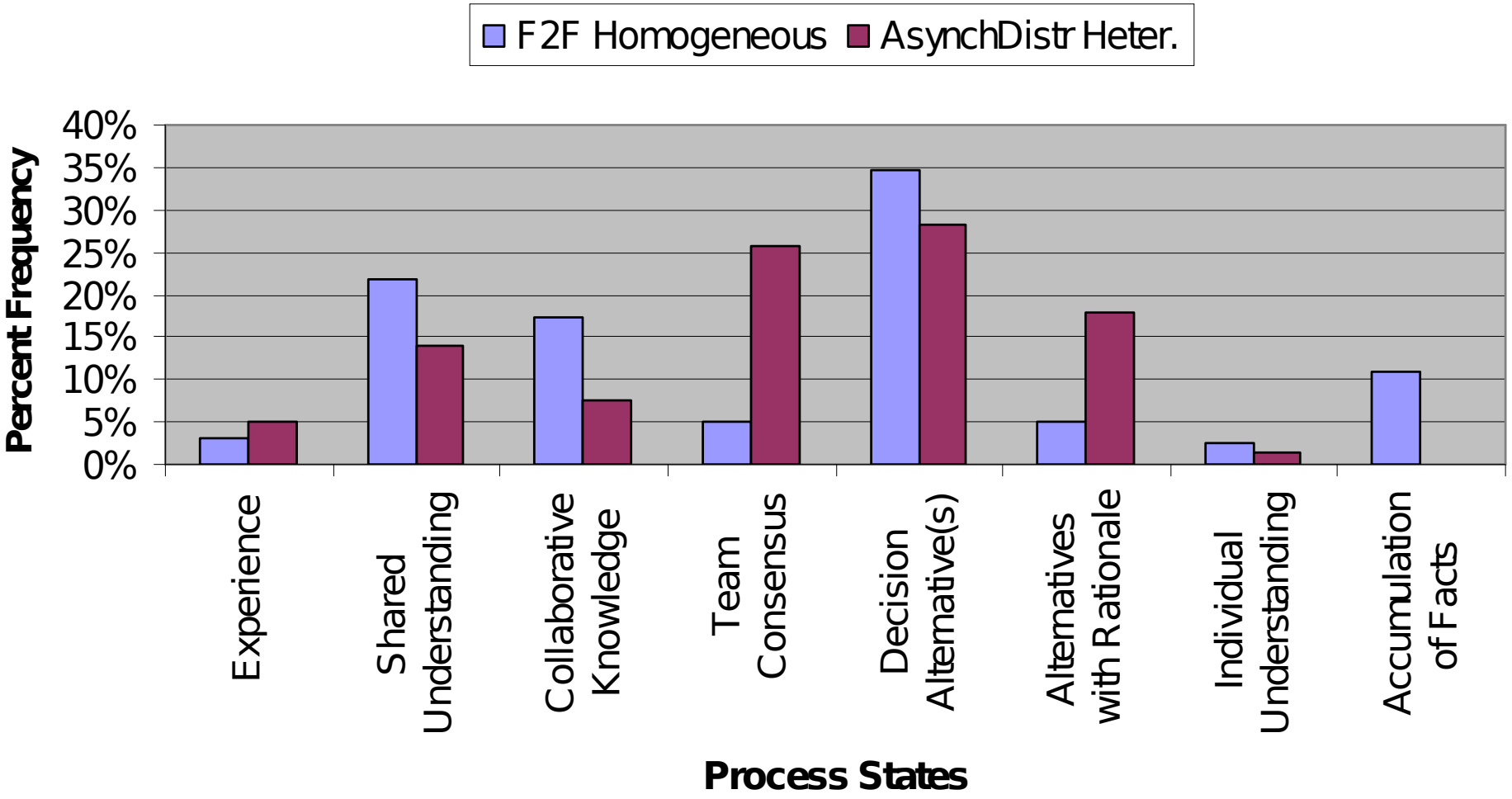


Pilot Study Results

Communication Analysis Example

Face-To-Face Homogeneous vs Asynchronous Distributed Heterogeneous

% Frequency by Process States



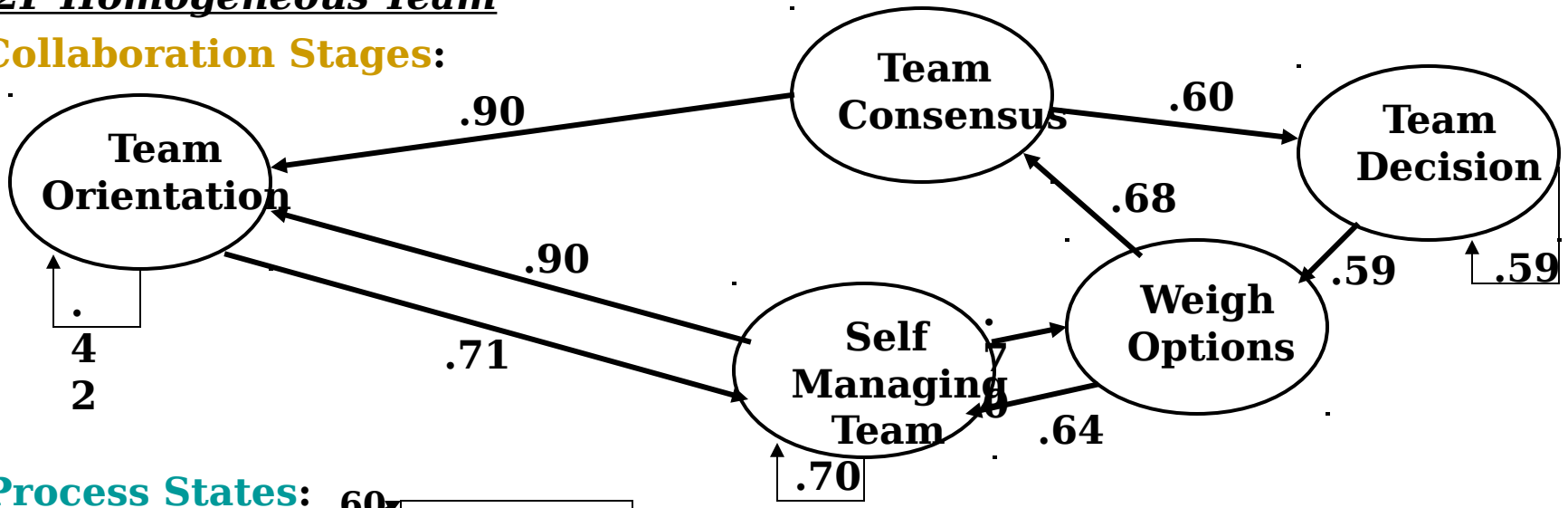
Pilot Study Results

Communication Analysis Example

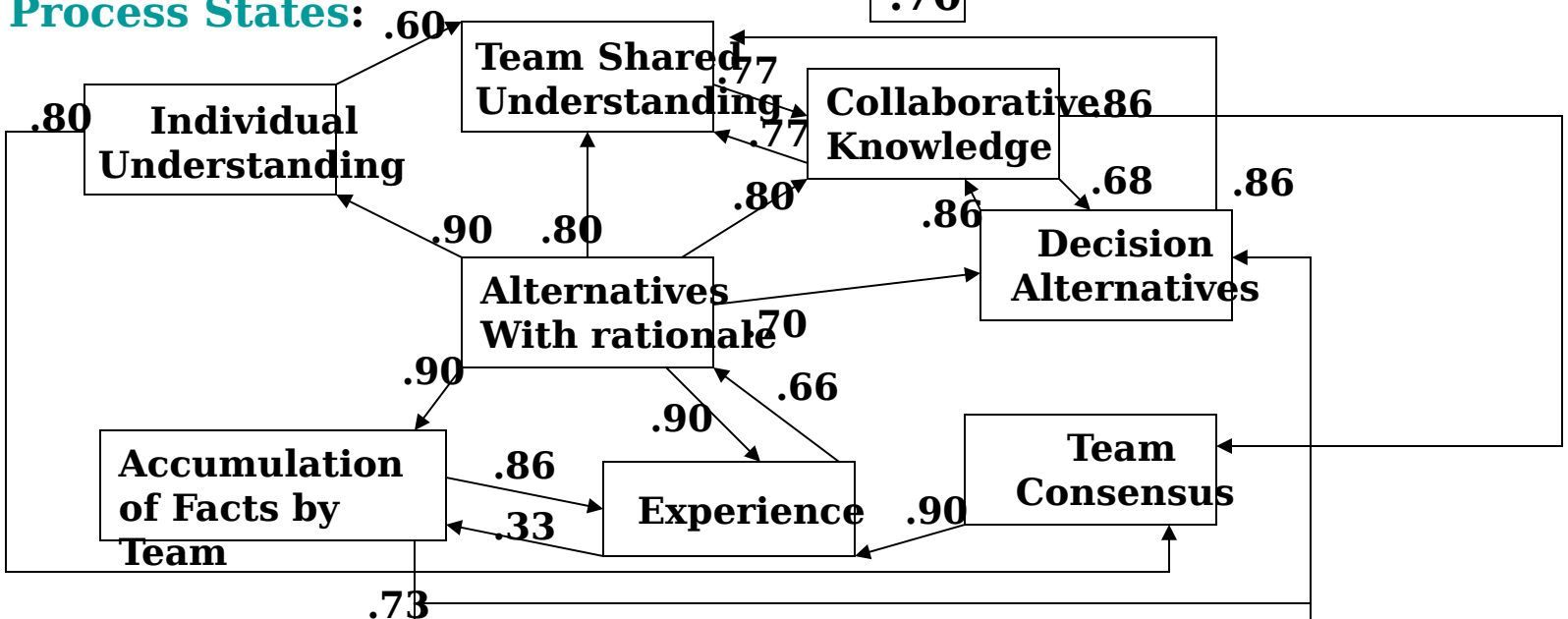
Pathfinder Results (relationships and strength of relationships)

F2F Homogeneous Team

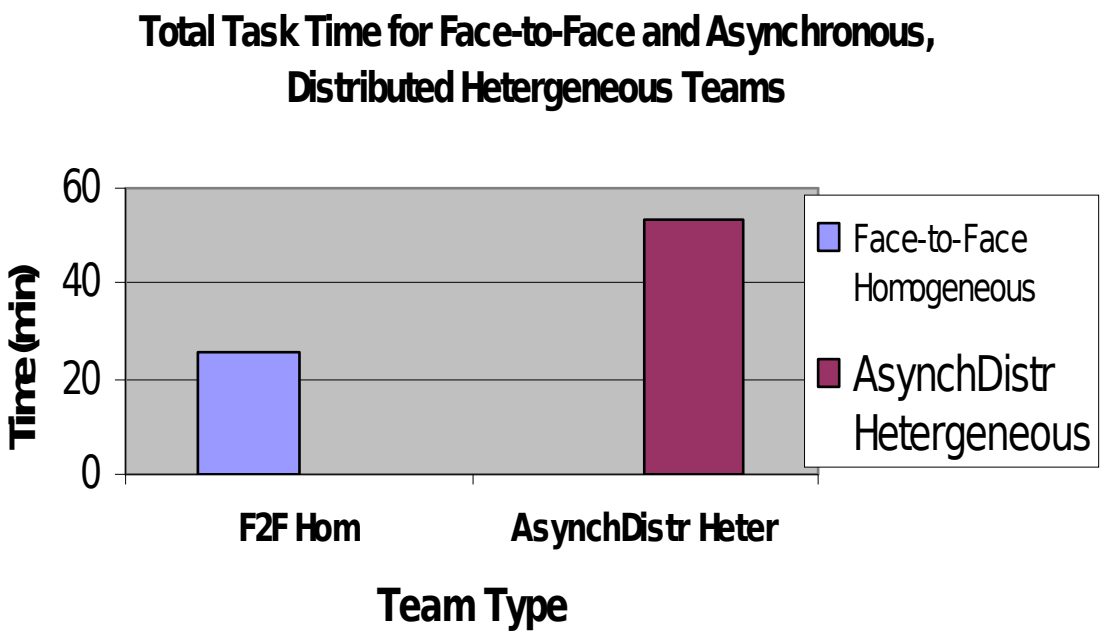
Collaboration Stages:



Process States:



Pilot Study Results
Time Analysis Example



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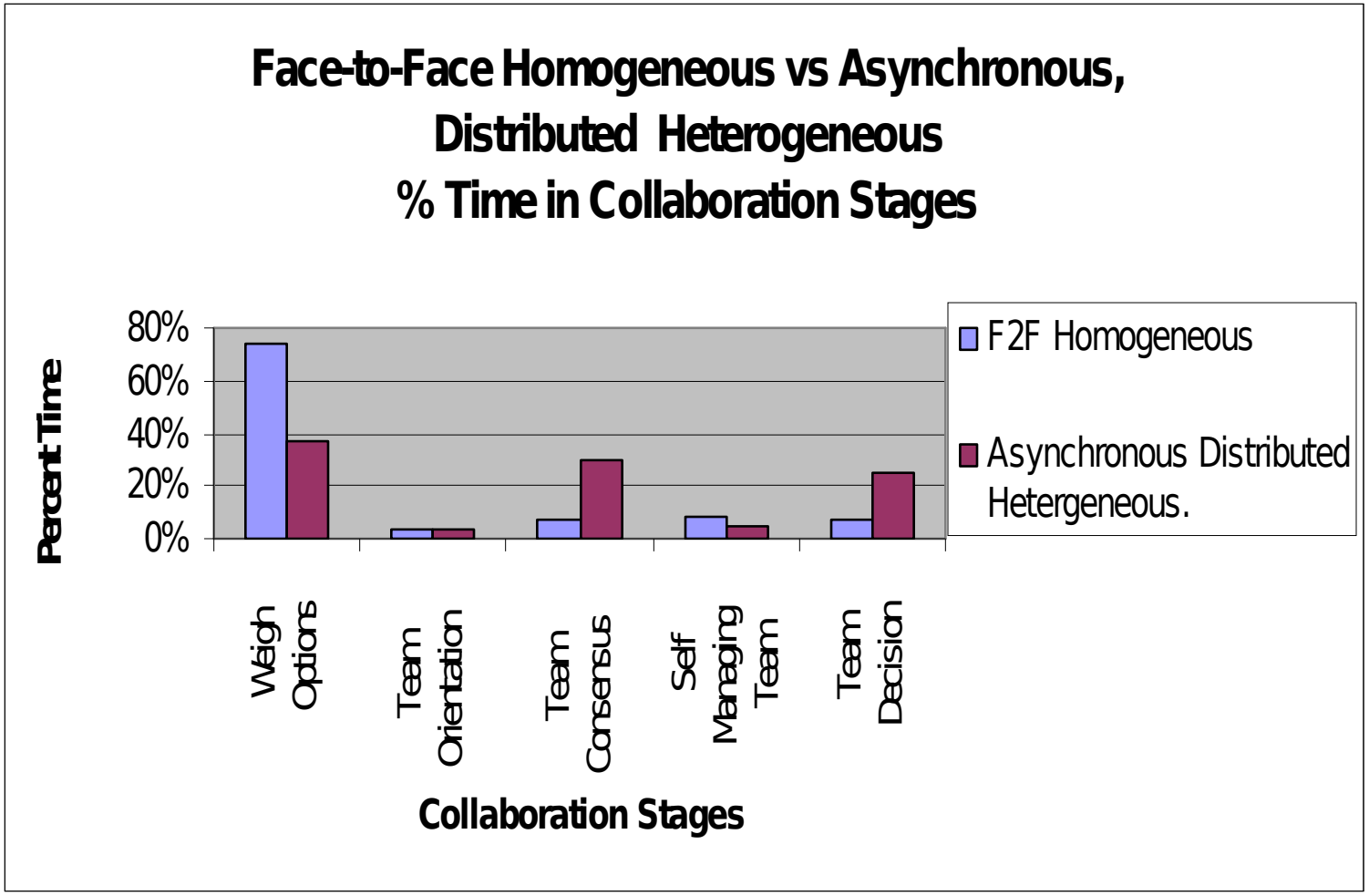
Time Analysis Example



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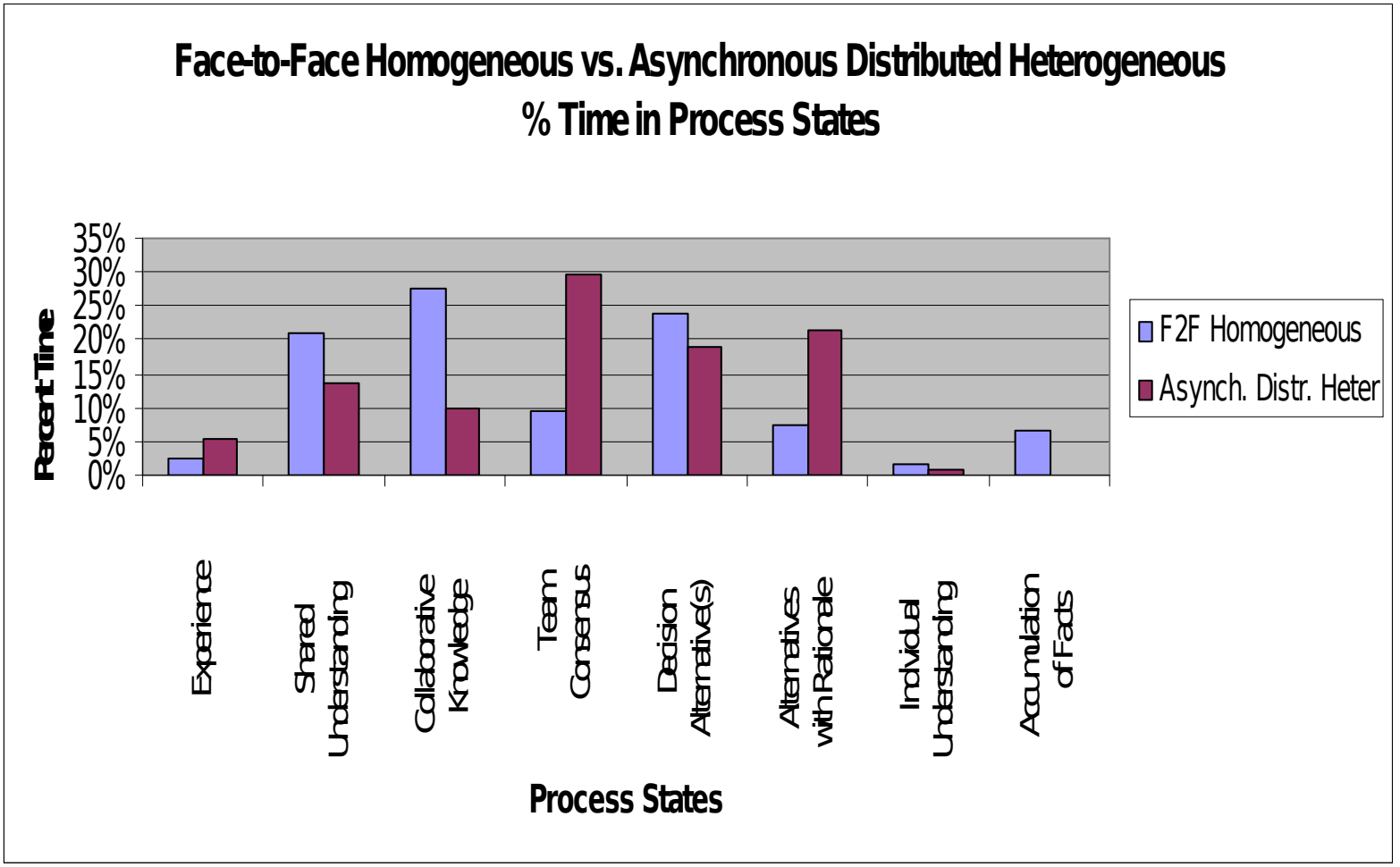


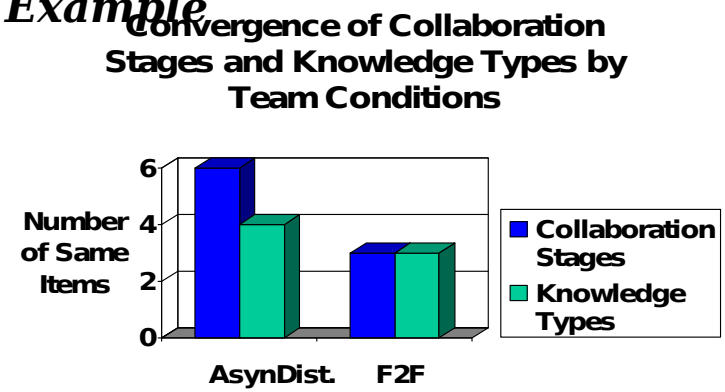
Pilot Study Results

Collaboration Maps (Post Session)

Face-To-Face Homogeneous vs Asynchronous, Distributed Hetergeneous Example

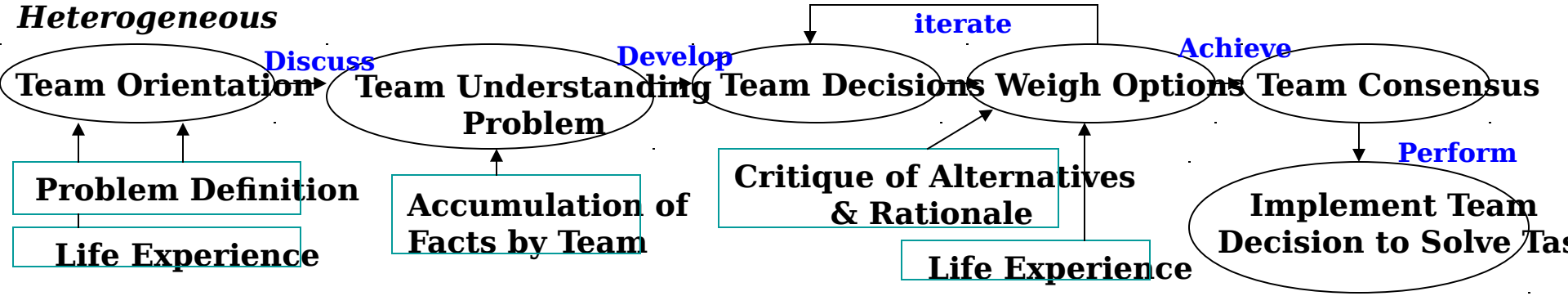
Questions:

- **Do individual mental models of the collaboration process converge?**
- **Do individual mental models correlate with actual team performance?**

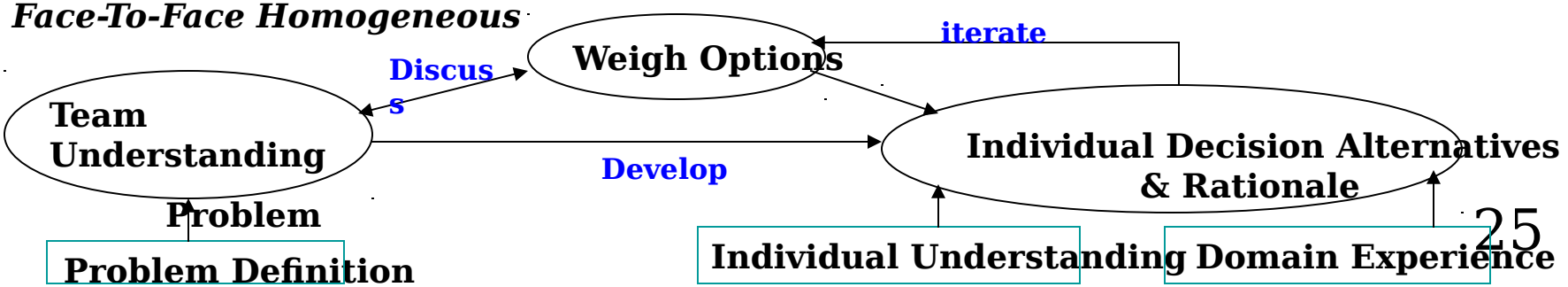


Resultant Collaboration Models

Asynchronous, Distributed Heterogeneous



Face-To-Face Homogeneous



Recent or Planned Publications and Demonstrations

• Warner, N.W., Vanderwalker, S., and Verma, N. (Planned Feb, 2003). A Conceptual Model of Knowledge Building during Asynchronous, Distributed Collaboration. Paper for journal article.

• Warner, N.W., Vanderwalker, S., and Verma, N. (Planned September, 2003). The Effect of Collaboration Mode and Knowledge Distribution on the Knowledge Building Process in a Asynchronous, Distributed Collaborative Problem Solving Task. Paper for journal article.

• Warner, N.W., NATO RTO Human Factors and Medical Panel 078/Task Group 017: Uninhabited Military Vehicles – Augmenting the Force. Invited United States Navy Representative, Leiden, Netherlands, June 2003.

Lessons Learned

- **Achieved better collaboration between team members with the Survival Scenarios compared to Age of Empires**

- **<u>Concept Maps</u> (Eden, 1992)**
  - **Could not capture individual or group mental models of the knowledge building process during asynchronous, distributed collaborative problem solving**
  - **Concept maps are good at capturing and representing discrete information on a topic but humans have difficulty in representing abstract information with this open ended technique**

- **<u>Collaboration Map</u> (Wasson, 2002)**
  - **Computer based structured approach to capturing individual menta collaboration stages and types of knowledge including transformati**

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